

Tornado Detection & Limitations



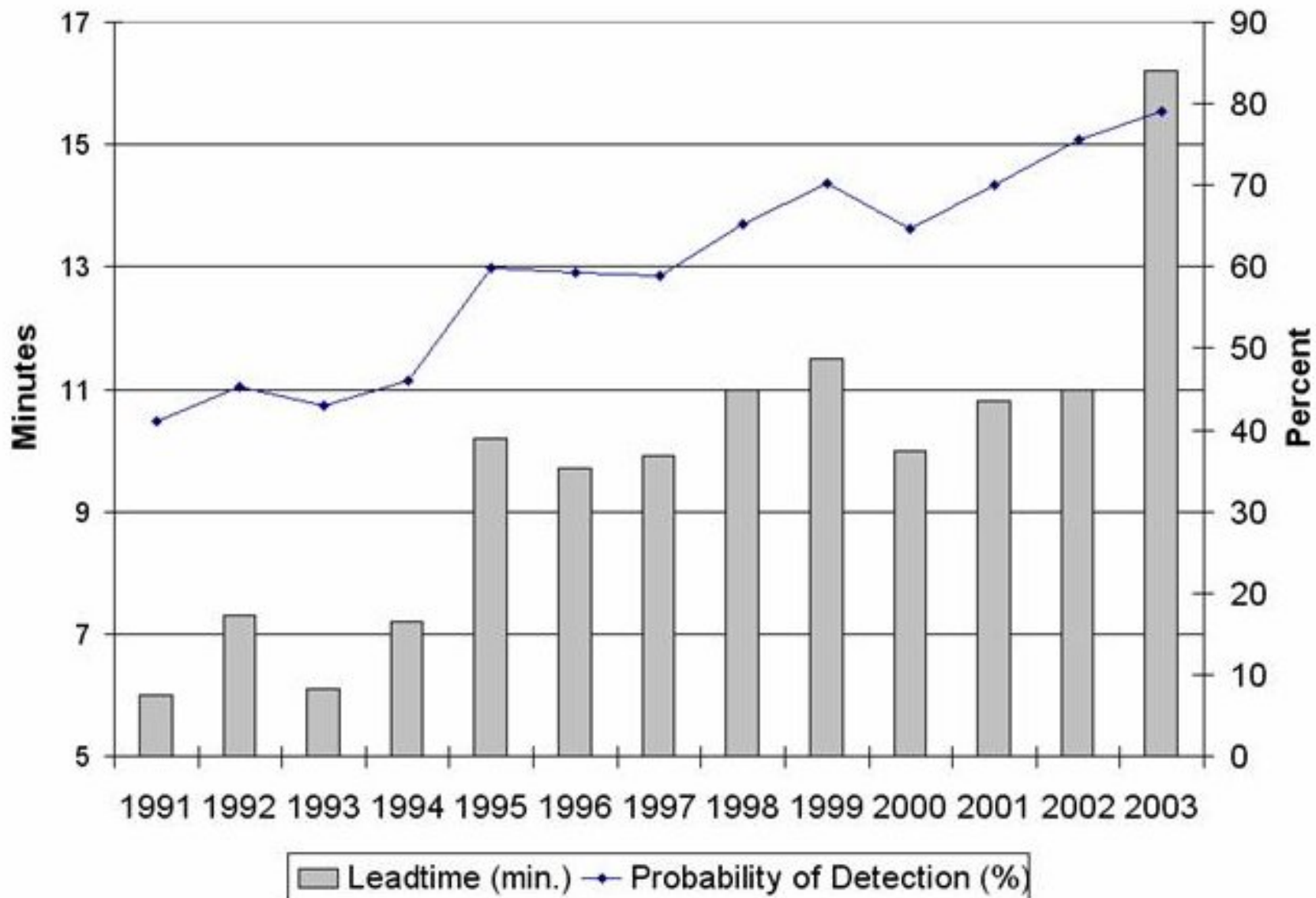
David Craft

Weather Forecaster

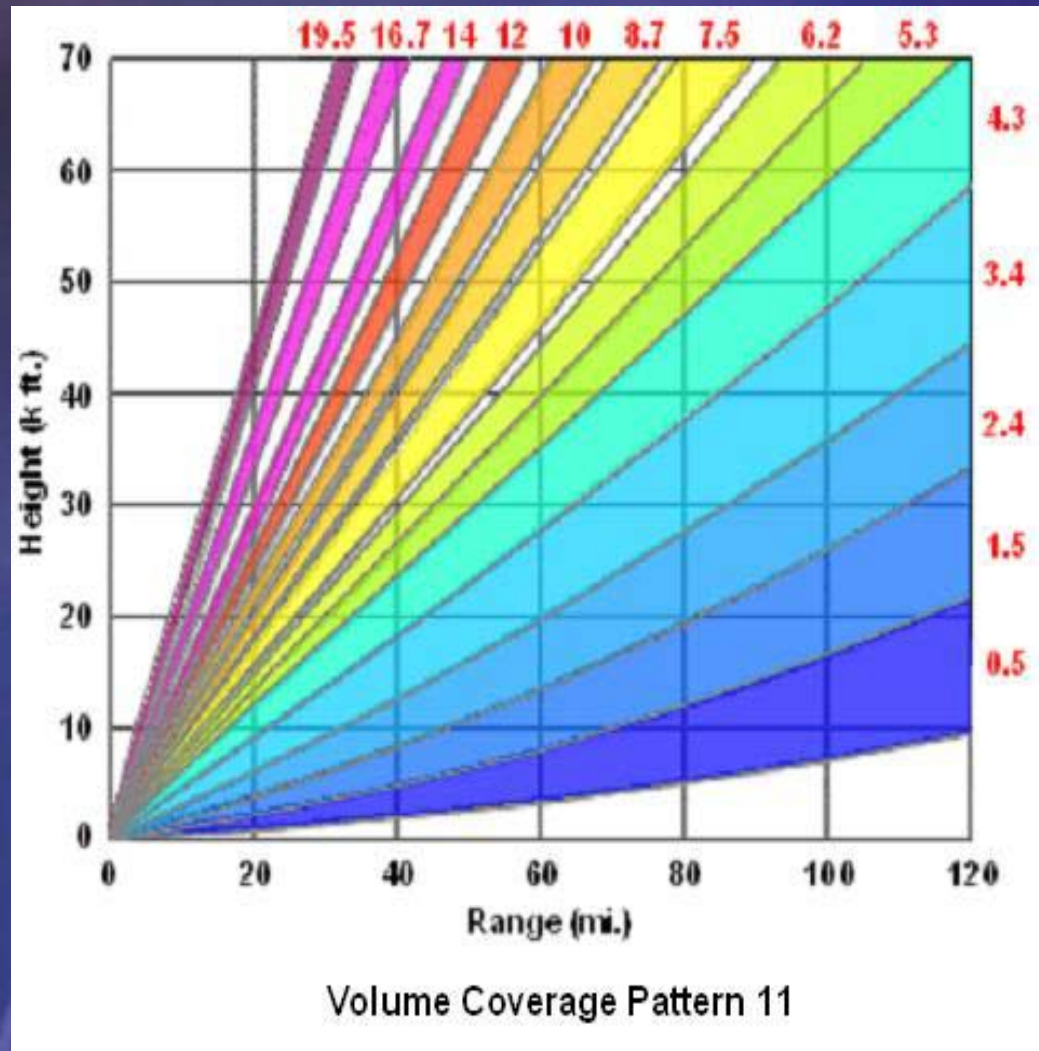
Overview

- **Background**
- **Doppler Radar Limitations**
- **Examples**
- **Other Tornado Detection Capabilities**
- **Prepare & React Appropriately**
- **References**
- **Bottom Line**

National Average Lead Times & Probability of Detection

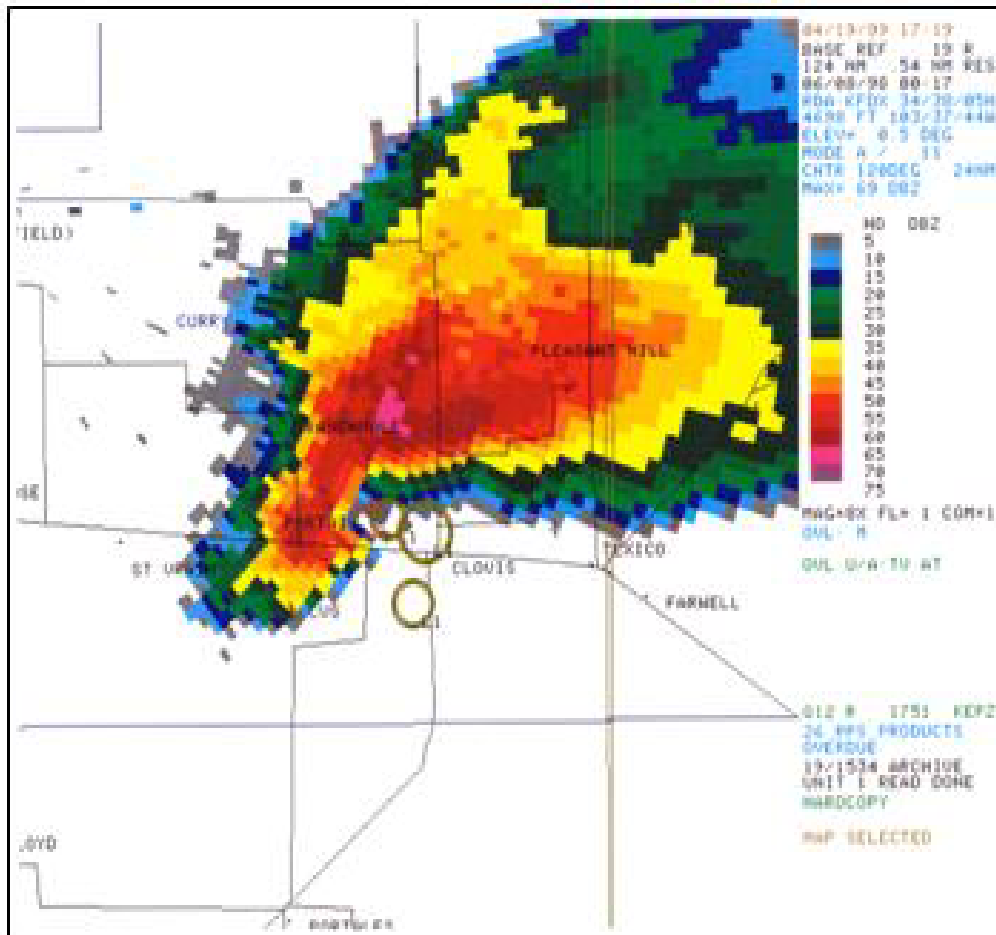


Weather Radar Basics

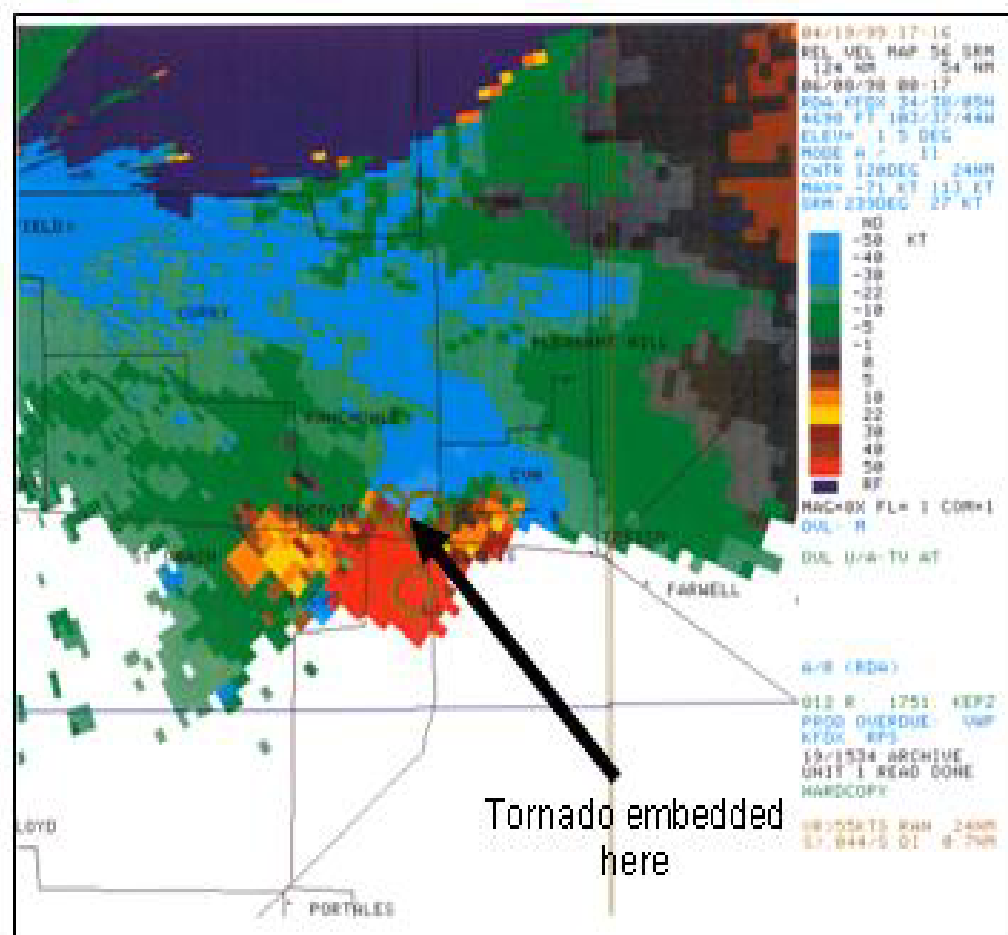


(NWS, 2003)

Weather Radar Basics



Base Reflectivity



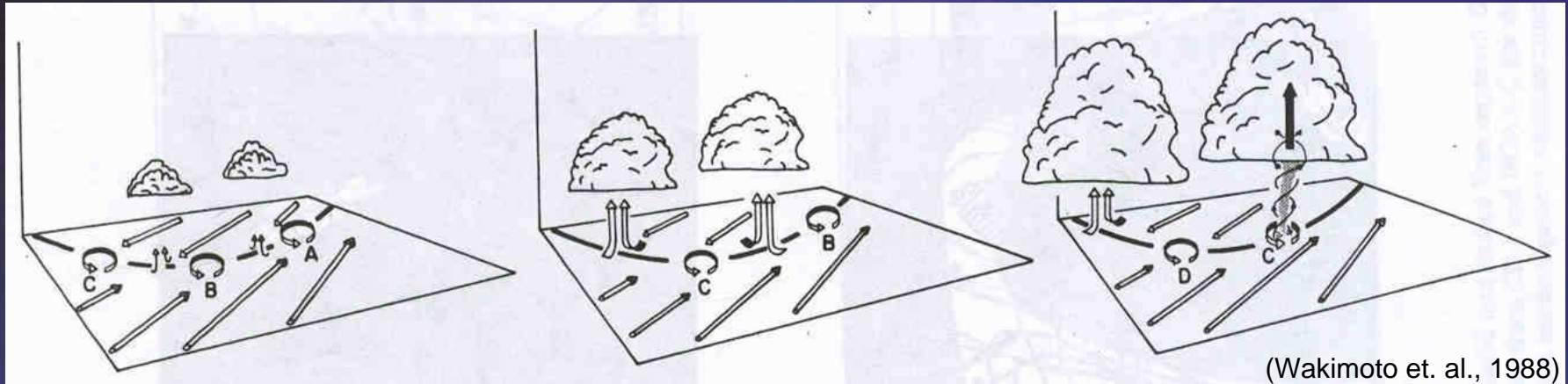
Storm Relative Velocity

Non-Supercell Tornadoes

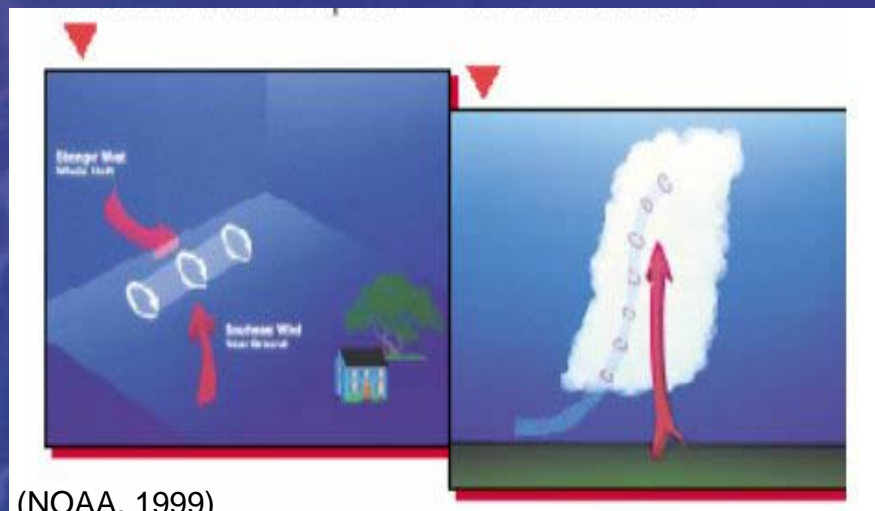
- **Probably more frequent in Western U.S.**
- **Often unseen or unreported**
- **Form early in thunderstorm lifecycle**
- **May form rapidly near surface then extend upward**
- **May form simultaneously at low and mid levels**
- **Shallow and/or narrow, brief**

Spin-Up Tornado Formation

- Cause 1: shear instabilities stretched upward by updraft



- Cause 2: horizontal vorticity tilted to vertical by updraft



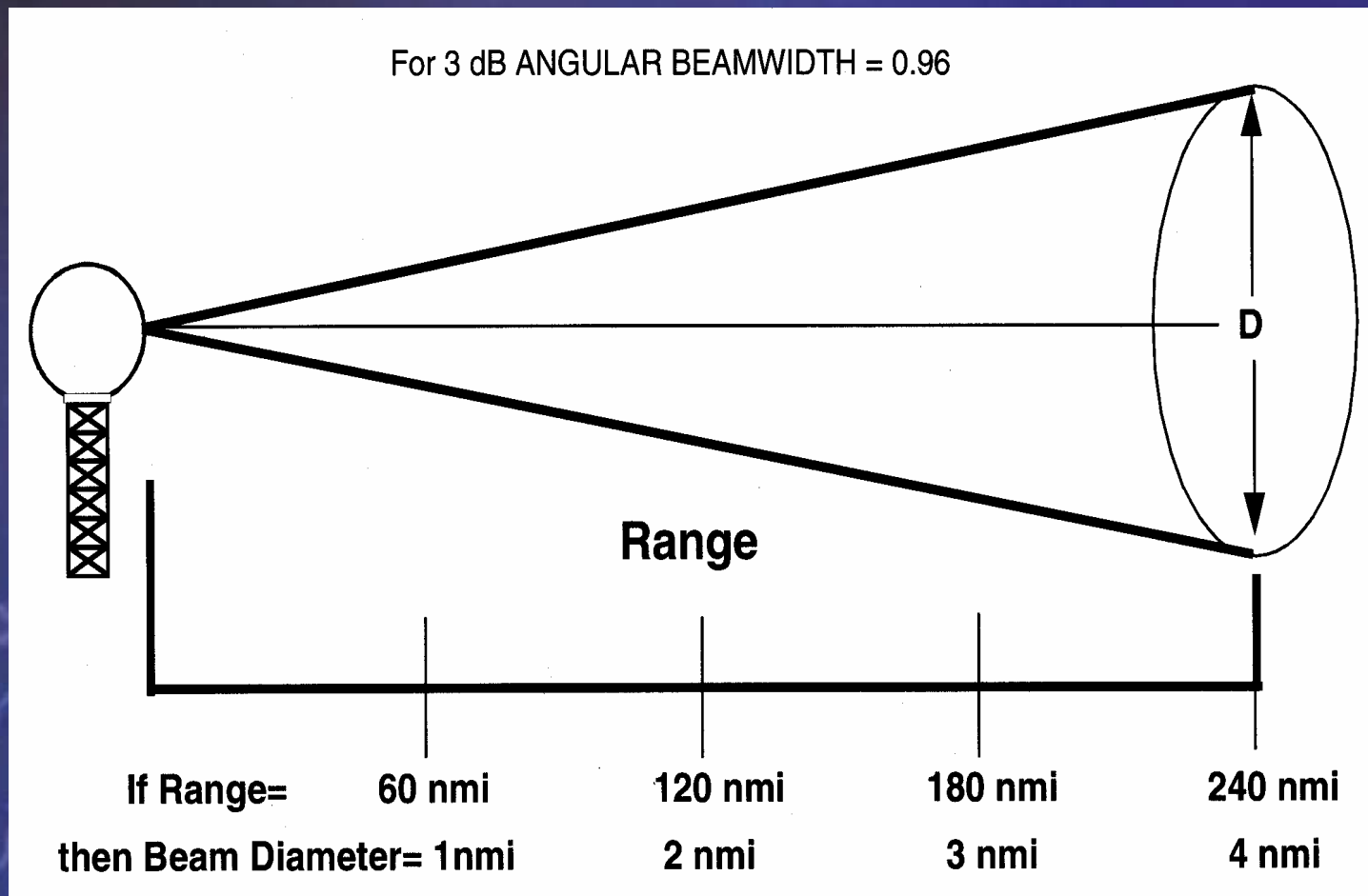
Doppler Radar Limitations

All Doppler radars have difficulty detecting circulations...

- **Too far from radar**
 - Beam broadening
 - Overshooting
- **Too close to radar**
- **Blocked from radar view**
- **Dissipate too quickly**

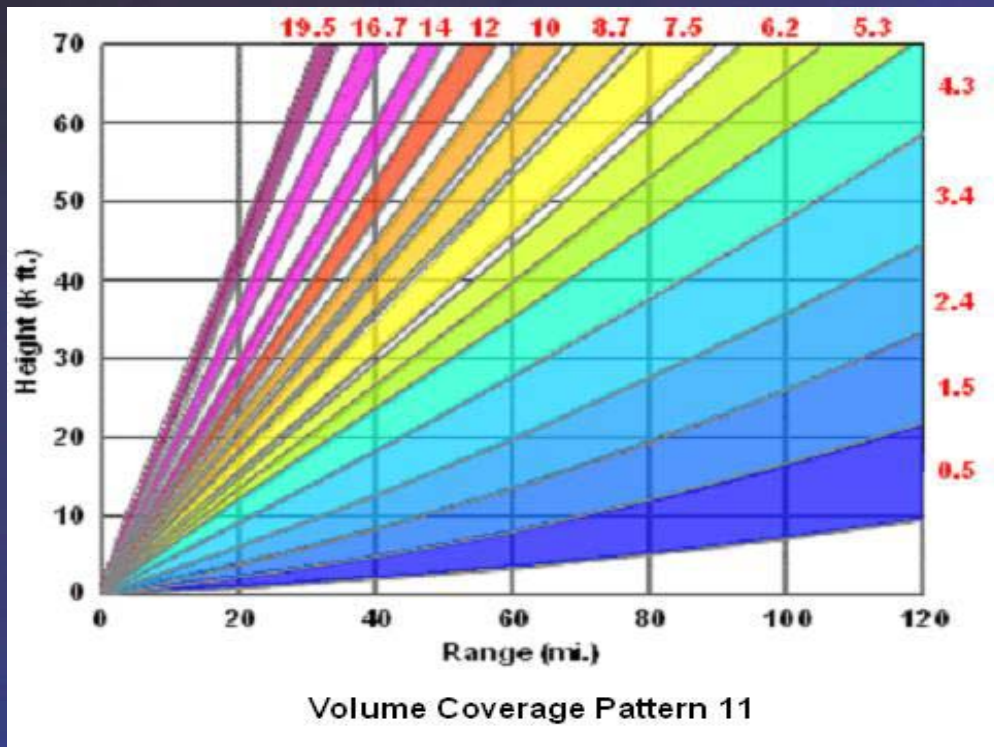
Limitation 1: Too Far From the Radar

Cause 1: Beam Broadening



Limitation 1: Too Far From the Radar

Cause 2: Overshooting



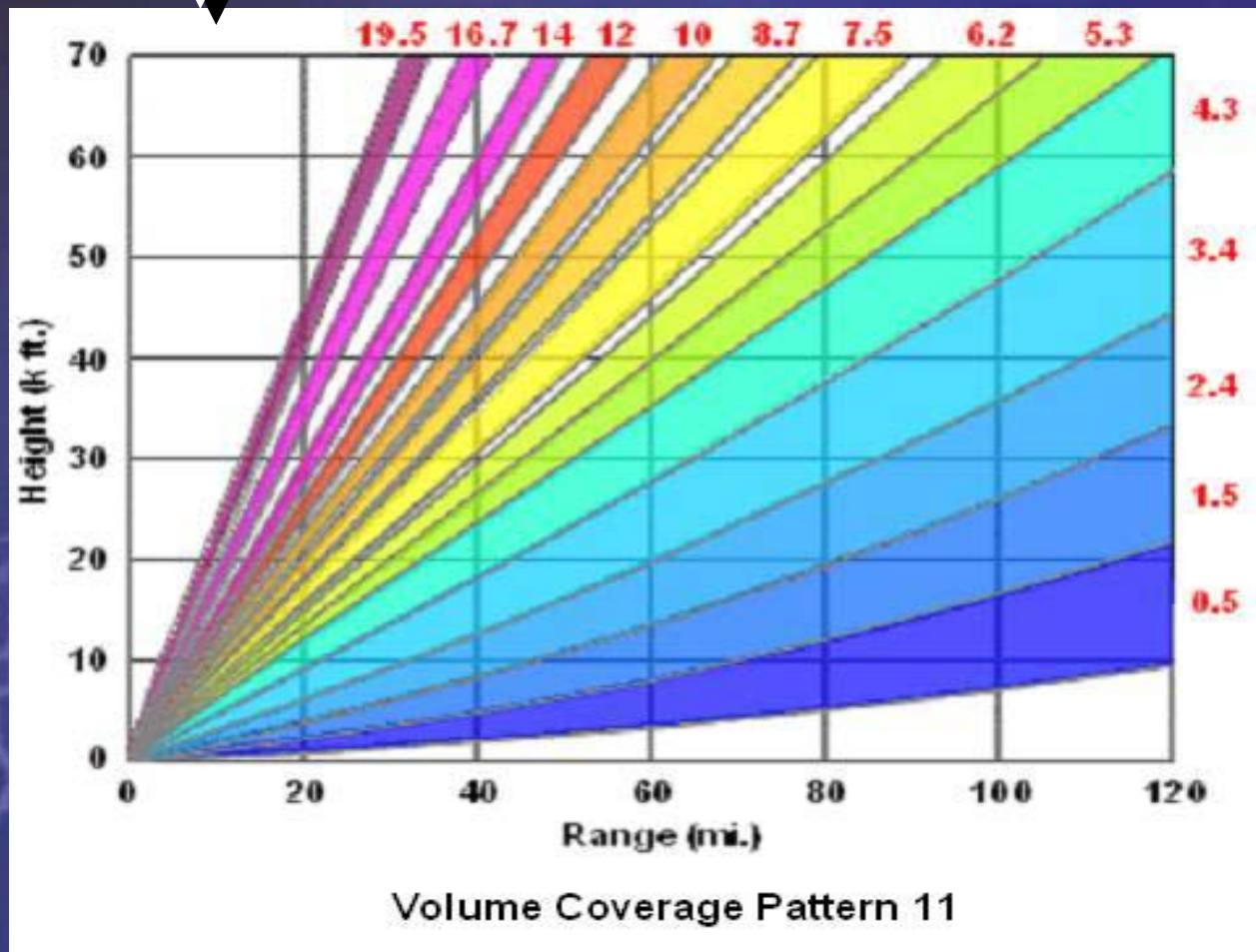
Angles Used



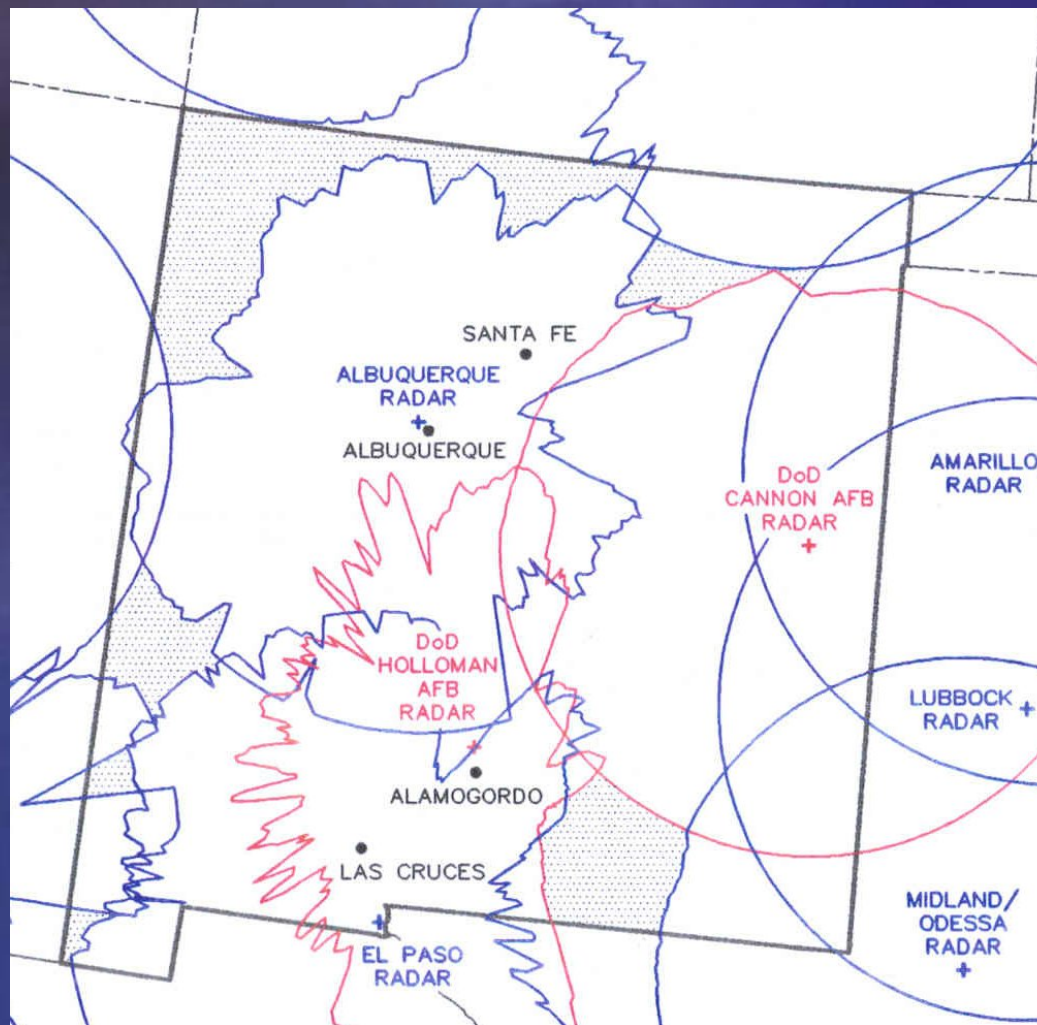
Radar Coverage

Limitation 2: Too Close to the Radar

Cone of Silence



Limitation 3: Blocked From View



Radar Coverage at 10,000 Ft

Limitation 4: Dissipate Too Quickly

- **Many spin-ups may last only a few minutes**
- **Complete atmosphere scan may take 5 or 6 minutes**
- **Even when detected, spin-ups frequently dissipate before a warning can reach people**
- **New scan strategies will shrink scans to 4.1 minutes**

Example 1: Spin-Up Below Cumulus Cloud

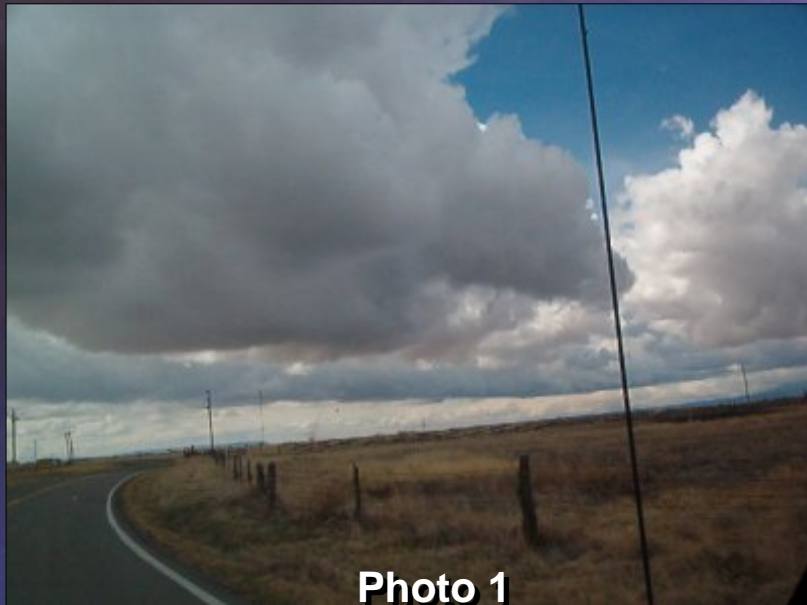


Photo 1

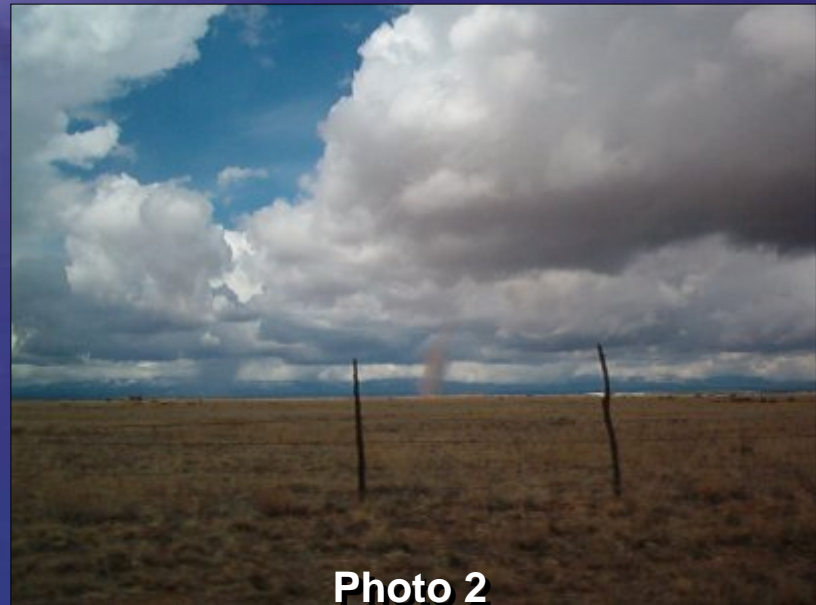


Photo 2



Photo 3

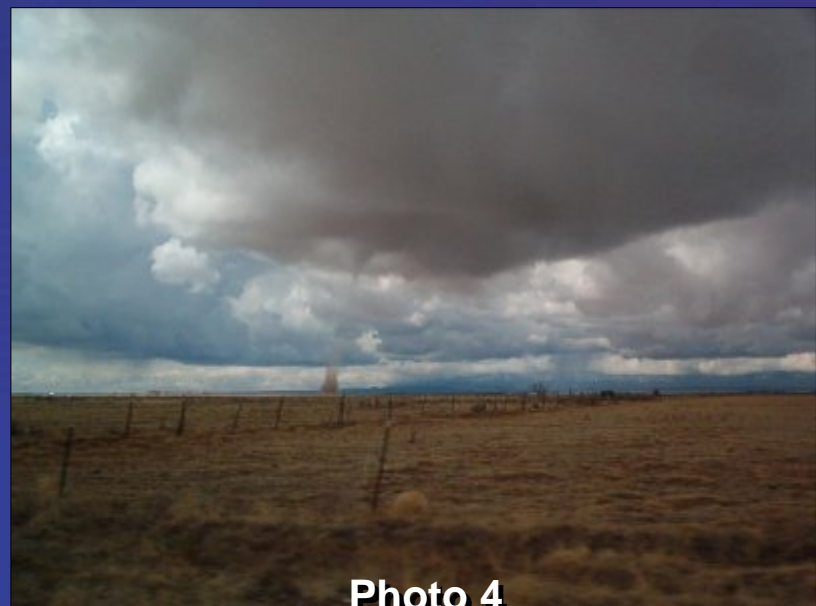


Photo 4

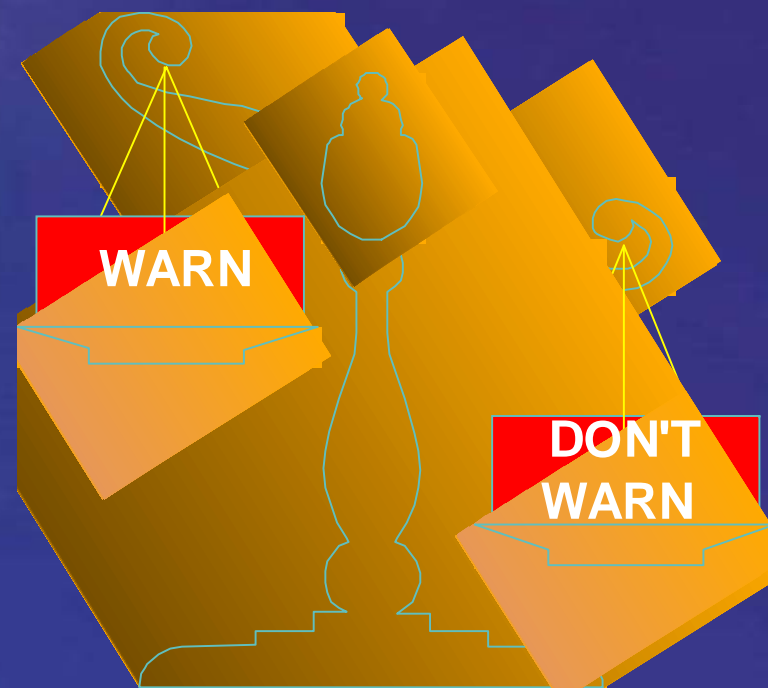
Example 2:

Spin-Up Below Thunderstorm



Other Tornado Detection Capabilities

- Storm Prediction Center guidance
- Weather models
- Satellites, profilers, soundings, upper-air data, surface obs
- Storm spotters
- News media, law enforcement and public reports



Prepare & React Appropriately

- **FEMA's tornado safety tips brochure:
www.fema.gov/hazards/tornadoes/tornadof.shtm**
- **Watch for small tornadoes with all thunderstorms**
- **U.S. hazards assessment**
- **Severe wx outlook, mesoscale discussions, watches**
- **Hazardous wx outlook & warnings**
- **Use NOAA weather radios**
- **Report tornadoes to NWS, if safely possible**

Bottom Line

- **WSR-88D's do a good job at what they're designed to do: detect strong mid-level circulations**
- **All weather radars have limitations**
- **Small tornadoes frequently exploit these limitations in New Mexico**
- **NWS forecasters use all available resources to overcome tornado detection limitations**
- **Weatherwise media & public can prepare for this dangerous threat and react appropriately when tornadoes strike**

References

- NOAA, 1999: Thunderstorms...tornadoes...lightning... nature's most violent storms. A preparedness guide. NOAA/PA #99050, ARC 1122, 16 pp. Cited 2004. [Available online at <http://www.nws.noaa.gov/om/brochures/ttl.pdf>].
- NWS, cited 2003: NWS radar FAQs page. [Available online at <http://weather.noaa.gov/radar/radarinfo/radarinfo.html>].
- Wakimoto, R.M., and Wilson, J.W., 1988: Non-supercell tornadoes. Mon. Wea. Rev., **117**, 1113-1140.
- WSR-88D Operational Support Facility and Titan Systems Group, July 1998: *WSR-88D Principal User Processor Operator Handbook*. Volume II, Applications Terminal, Software Version 10.0, 267 pp.

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Questions for David Craft?

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